Symposium: 15th International ASTM/ESIS Symposium on Fatigue and Fracture Mechanics (40th ASTM National Symposium on Fatigue and Fracture Mechanics)

Paper Title: Crack instability predictions using a multi-term approach

Authors: Mohammad Zanganeh[1] and Royce G. Forman[1]

[1] NASA Johnson Space Center, Houston, Texas.

Abstract: Present crack instability analysis for fracture critical flight hardware is normally performed using a single parameter, K_C, fracture toughness value obtained from standard ASTM 2D geometry test specimens made from the appropriate material. These specimens do not sufficiently match the boundary conditions and the elastic-plastic constraint characteristics of the hardware component, and also, the crack instability of most commonly used aircraft and aerospace structural materials have some amount of stable crack growth before fracture which makes the normal use of a K_C single parameter toughness value highly approximate. In the past, extensive studies have been conducted to improve the single parameter (K or J controlled) approaches by introducing parameters accounting for the geometry or in-plane constraint effects. Using 'J-integral' and 'A' parameter as a measure of constraint is one of the most accurate elastic-plastic crack solutions currently available. In this work the feasibility of the J-A approach for prediction of the crack instability was investigated first by ignoring the effects of stable crack growth i.e. using a critical J and A and second by considering the effects of stable crack growth using the corrected J-Δa using the 'A' parameter. A broad range of initial crack lengths and a wide range of specimen geometries including C(T), M(T), ESE(T), SE(T), Double Edge Crack (DEC), Three-Hole-Tension (THT) and NC (crack from a notch) manufactured from Al7075 were studied. Improvements in crack instability predictions were observed compared to the other methods available in the literature.